

A Novel Electromagnetic Field Detector for Extremely Low Frequency Energy

¹, Z. H. Bohari, ², M. F. Sulaima, ³, M. N. M. Nasir, ⁴, W. M. Bukhari,
⁵, M. H. Jali, ⁶, M. F. Baharom

^{1, 2, 3, 4, 5, 6}, Department of Diploma Studies, Faculty of Electrical Engineering, UTeM

ABSTRACT

Electromagnetic fields (EMF) produce huge impact in any modern society. It is well known that a strong electromagnetic field can cause acute effects, such as burns. The mechanisms behind such effects are sustainable. However, the concerning effect on long-term exposure to weak fields may prove bad influent towards human physical. Because the exposures are widespread, even small health effects can have profound public health implications. This project designed an Electromagnetic Field Detector (EMF) which can detect the radiation especially on electronic device. This EMF has many types of radiation such as microwave, ultraviolet, gamma-rays, x-rays and etc. The EMF sensor described, measures the range of radiation in very low frequency in range of 50 Hz. The circuits can assess the range of radiation from EMF source, such as electrical socket outlet when it switched through LED indicator. The pulsation of radiations can be visualized through the flashing of LEDs. This project presents the sensor operating principle, design of the project and processing sensor data, and some preliminary experimental results. In this project, Proteus Software used to design and simulate the circuit and then proceed with the hardware based on Proteus circuit.

KEYWORDS – electromagnetic field (EMF), pulsation radiation, Proteus.

Date of Submission: 05 May 2014



Date of Publication: 20 June 2014

I. INTRODUCTION

In our daily life, there are a lot of electronic devices that still have small radiation even the devices is turned off without being unplugged. Basically, these devices can be found in home applications such as computer's battery, microwave, wireless telephone, television and etc. For example, this can be happens during work on computer or watch the TV, where the body is engulfed in an 'electronic smog' emanating from the device; referring the EMF outlet sockets. In CRT-based monitors, the spot of electrons that sweep the screen can generates pulsed electromagnetic radiation (PEMR) [1]. This energy will escapes in the form of radiations in very low-frequency and extremely low-frequency energy. Thus, these unnatural radiations behavior can disrupt the body's bio magnetic field within which millions of electrical impulses regulate the activities of the cells [2]. Unfortunately, the continuous exposure to PEMR can cause adverse effects to the human without our concerning on it in our daily life [2].

Radiation is a broad term meaning the transmission of energy in the form of waves through space or through a material medium and also the radiated energy itself. The force field associated with radiation is the region throughout which the radiation is measurable. Sometimes electromagnetic radiation is called EMR, while electromagnetic fields are frequently referred to as EMF. EMR and EMF refer to the entire range of the electromagnetic spectrum, from extremely low frequencies to radio waves [2, 3]. In practice, EMF is used more often than EMR because "radiation" sounds scary and its use may create confusion with more dangerous radiation from X-ray machines and radioactive material. In news reports and articles written for the general public (such as this article), EMF is used loosely to indicate the low frequency electromagnetic fields coming from power lines, home wiring, appliances, TVs and computer displays [2, 3].

EMF from different sources can either add together or cancel each other out. This is due to the wave characteristics of electromagnetic radiation. If the radiation from two sources is in phase, then the peaks of each cycle will collide, and the fields will be added together [4]. On the other hand, if the two sources are exactly out

of phase, then one source will be reaching its greatest strength in one direction at exactly the same time as the other source is peaking in the opposite direction [4]. If the magnitude of the fields is identical, then the fields will cancel each other out, and the magnetic field measurement will be zero. This is why neutral and hot wires in household wiring need to be paired close together. This characteristic also provides a mechanism for configuring power lines and VDTs so that EMF levels are reduced.

EMF can be either man-made or occur naturally. Examples of electromagnetic radiation, in order of increasing frequency, are extremely low frequency (ELF), very low frequency (VLF), radio waves, microwaves, infrared (heat), visible light, ultraviolet, X-rays, and gamma rays [5]. All electromagnetic radiation travels at the speed of light.

The frequency of the electromagnetic radiation is what determines its character. X-rays (and other forms of ionizing radiation) can strip electrons away from an atom, thereby creating an "ion." When living systems are exposed to such radiation, detrimental effects are caused by breaking apart molecular bonds [6]. Cancer can be caused by such ionizing radiation when DNA (the molecules that make genes) is broken apart. At ELF frequencies, electromagnetic radiation is non-ionizing, meaning it cannot knock electrons away from atoms or alter molecular structures. However, low frequency electromagnetic radiation is nevertheless an energy force, and this energy force can shake atoms and molecules back and forth. The field strength of electromagnetic fields can be calculated mathematically.

This section describes some of the study that has been conducted by people who studied on electromagnetic radiation based system. It will partially summarize the report and patents that Dr. Muhammad Fahmi Miskon who is a senior lecturer in Faculty of Electric in 2007 has made a project report title 'A novel electromagnetic signature sensor for mobile robots'. This paper describes the design of a novel electromagnetic radiation (EMR) signature sensor that is proper for use on a mobile robot [7]. The aim of this project is to produce a sensor to detect the electronic circuits. An EMR sensing robot can be used to locate and recognize electronically controlled explosive or illegally electronic devices used by passenger in an airplane. His project also includes the design of the project and processing sensor data. Results from the report shows in order to investigate the possibility of using the signatures to recognize electronic devices, measurements of the number of peaks, the time between peaks, the minimum and maximum time between peaks were taken from a CD player, and two different hand phones. A histogram of 40 samples of time between peaks was also created. [7]

Besides that, a patent on electromagnetic radiation detector which has been invented by Aslan, Edward .7 Netto Lane Plainview also will be discussed in this part of the proposal. The title of the patent is 'Wide power range electromagnetic radiation detector'. This invention basically relates to radiation monitor and to measuring instruments suitable for monitoring radiation of electric fields over wide power range. Diode detectors have been commonly used in radiation monitors. The diode detector in details includes a first and second diode which have their cathodes interconnected and to ground. Each diode has an intrinsic shunt capacitance associated with it. A radiation monitor employed the dual diode and the other amplifier being connected to the anode of the other diodes. The radiation monitor also includes a comparator circuit which selects the appropriate diode output signal based upon the level of at least one of the signals. A graph illustrates the response of one form of the diode detector over frequency. [8]

There is also a patent entitled 'System and component for detecting electromagnetic radiation and displaying images produced thereby'. This patent has been invented by Yehoshua, Gur 1/1 Mishmar Havgui St. Ramat Eshkol Jerusalem (IL). The present invention relates to a system for sensing electromagnetic radiation and displaying images produced by such radiation. The invention also relates to a camera for detecting, and a display unit for displaying, such images, and systems utilizing such cameras and display units. The term "electromagnetic radiation" is included the entire visible spectrum of light [9].

This research purposely designed a new device that can detect EMF radiation. The detection will help to analyzed and determine the frequency value of the electromagnetic field on the electronic devices. The risk of each electronic devices EMF can be detected easily. This project focuses more on an electromagnetic field detector that can detect an electromagnetic field in extremely low frequency (ELF) energy which is 50Hz by using open loop EMF.

II. METHODOLOGY

In order to complete this project smoothly, the planning of the project planned as per flow chart in Figure 1 below.

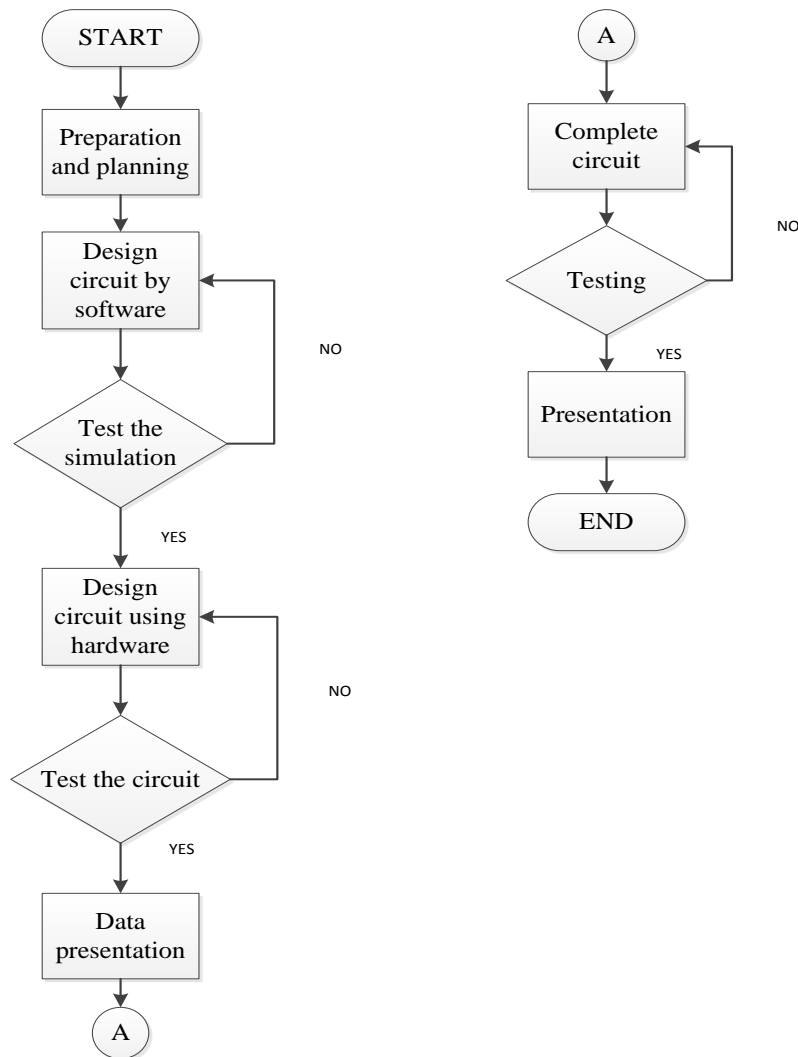


Figure 1: The flowchart of project plan

A. Project planning

As a start, during first two weeks, some preparation and planning have been done to identify and search about the electromagnetic field (EMF) based detection system. From there, a discussion among group members have been decided to make a detector that can detect electromagnetic field. Then, proposal is submitted on the second week. In the following weeks, the circuit have been designed by using ISIS Proteus software and the simulation is tested. When the testing is complete, we brought the electronic components correspond to our list budget. Later on, the circuit is built practically in hardware and test the electromagnetic field sensor properly during week 5 and week 6. Next stage is a data presentaion where we ar tested by receiving the measured value as the data are display. After that, the complete circuit are developed for about three weeks. In that time, the progress report are submit. On the week 12, the electromagnetic field detector is tested on electronic devices. In the final stage, during week 13, the presentation is held and the complete final report is submitted.

B. The procedure of the circuit

The schematic diagram of the Electromagnetic field circuit have been done by using ISIS 7 Professional software.

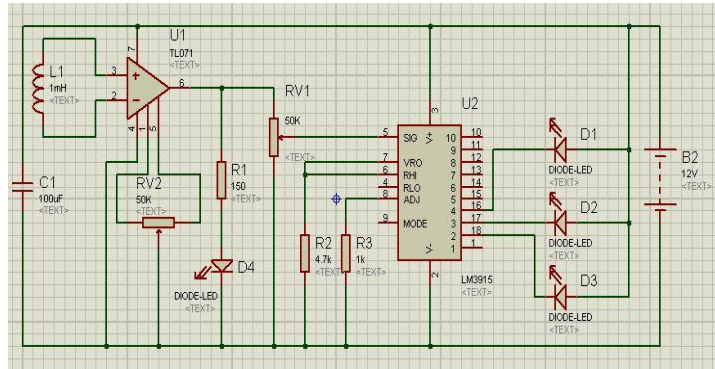


Figure 2: The schematic diagram of Electromagnetic field circuit

In Figure 3 below shows the flow of the circuit operation during the simulation is turned ON.

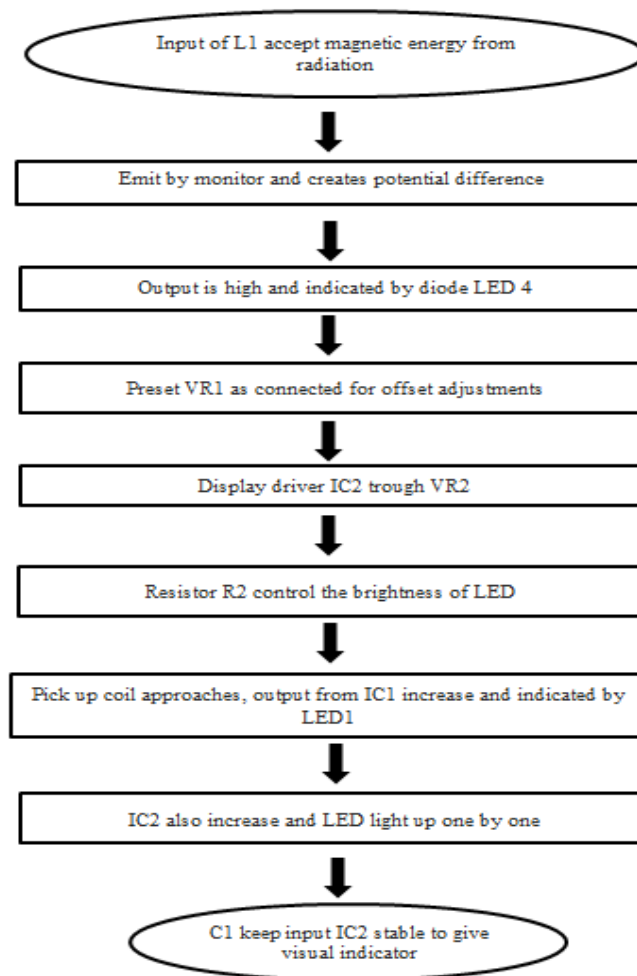


Figure 3: The procedure of the circuit flows

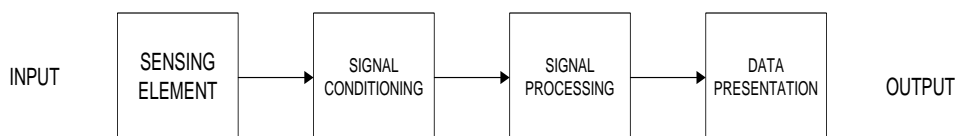


Figure 4: The process of sensing element

1) Sensing element

- In contact with the process and gives an output which depends in some way the variable to be measured.
- For this project, EMF sensor will be used to collect energy from the radiation.

2) Signal conditioning

- Takes the output of the sensing element and converts it into a form more suitable for further processing usually a DC voltage, DC current or frequency signal
- The amplifier will amplifies low input voltage to high output voltage.

3) Signal processing

- Takes the output conditioning and converts into more suitable for presentation.
- An IC will be used to scale the output from the Op-Amp logarithmically.

4) Data presentation

- Present the measure value in form that can be easily recognised by an observer.
- LED light will used as a form indicator for the observer.

Figures and Tables

To ensure a high-quality product, diagrams and lettering **MUST** be either computer-drafted or drawn using India ink.

III. RESULTS & DISCUSSIONS

A. Simulation

During the simulation test, the inductor of the input is changed to the battery as the input sensor so that the simulation can operates functionally. Figure 5 below shows when switch is normally close while Figure 6 shows when the switch is opened.

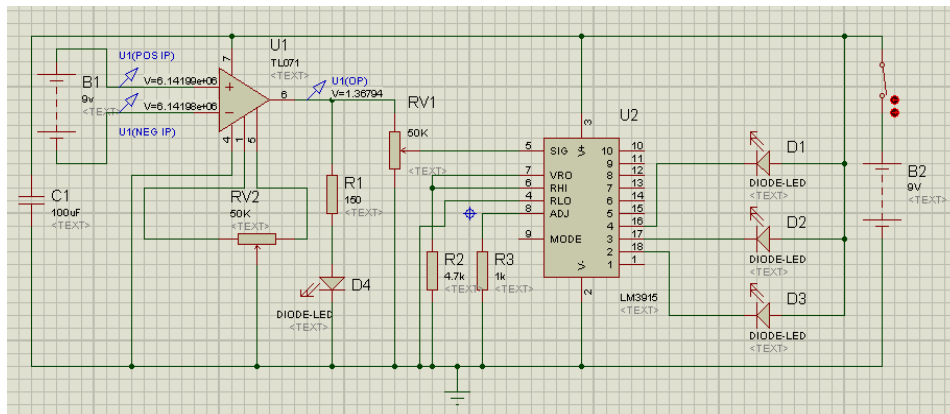


Figure 5: Switch is closed

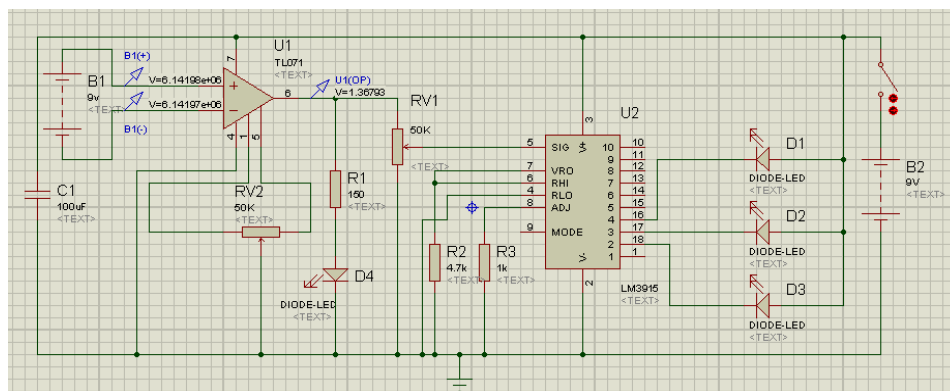


Figure 6: Switch is opened

B. Hardware

B.1 Part 1

The testing of the hardware circuit is carried out by using oscilloscope as the instrument to measure the voltage at the output of the Op-Amp. The EMF source that has been used was the battery laptop charger (DELL) that was connected from power source of 240Vac with the frequency of 50Hertz. Part A is where the sensor is put away from the electromagnetic source. Part b, part c, and part d is where the sensor was put at a distance where the led 1, led 2 and led 3 glows one by one respectively.

- a) At initial condition where the sensor is not detected any electromagnetic field radiation.

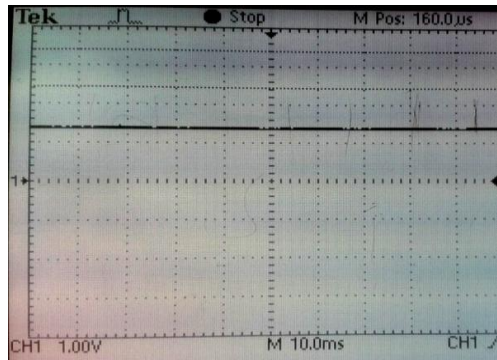


Figure 7: Graph of output voltage from Op-Amp at initial state.

The graph shows that the Op-Amp output voltage is not having any oscillation due to no output from the sensing element.

- b) The sensor is put at a distance where the first led (led 1) glows.

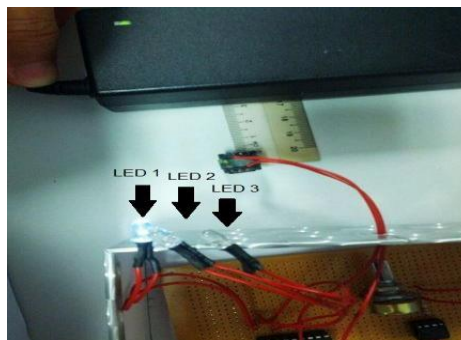
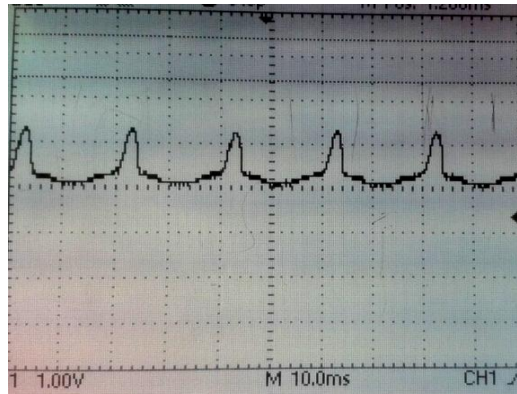


Figure 8: Graph of output voltage from Op-Amp at distance where the sensor was put 3.2cm from the EMF radiation source.

The graph shows there is an oscillating voltage output cycle from Op-Amp when the sensor was detecting EMF radiation at distance of 3.2 cm. This was indicated by the led 1 lighted up. The output voltage is $1.28V_{P,P}$ at the frequency of 50Hz.

- c) The sensor is put at a distance where the first and second led (led 1 and 2) glows.

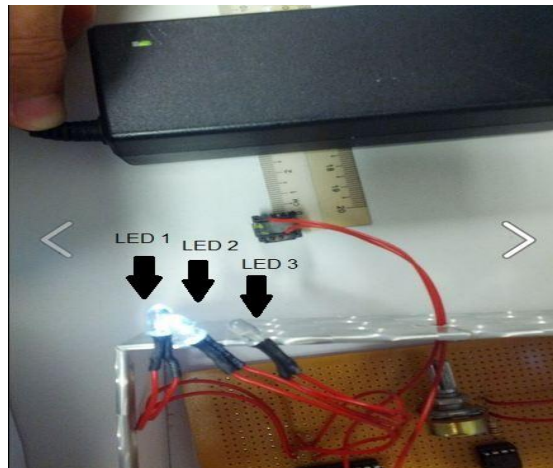
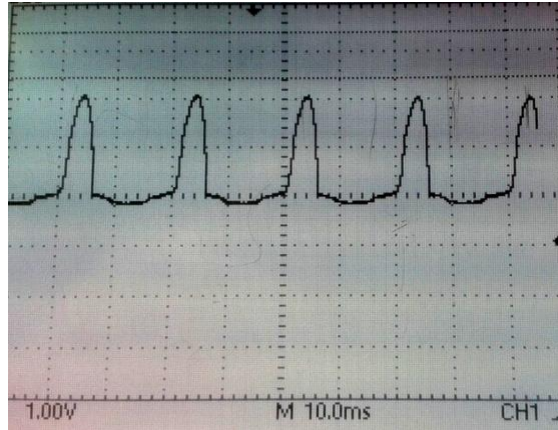
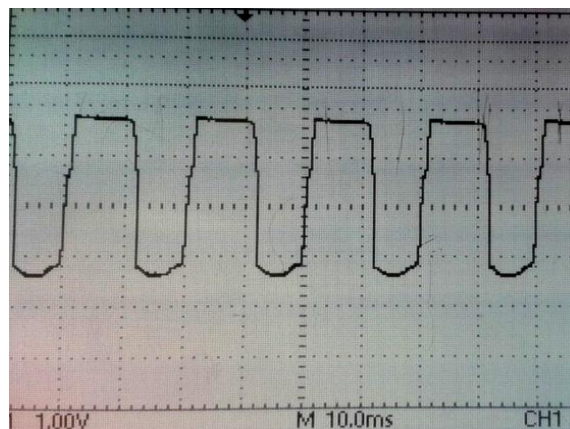


Figure 9: Graph of output voltage from Op-Amp at distance where the sensor was put 2.9cm from the EMF radiation source.

The graph shows an oscillating voltage output cycle from Op-Amp when the sensor was detecting EMF radiation at distance of 2.9 cm. The output voltage is at $2.24V_{P,P}$ at the frequency of 50Hz.

- d) The sensor is put at a distance where all LEDs (led 1, 2 and 3) glows.



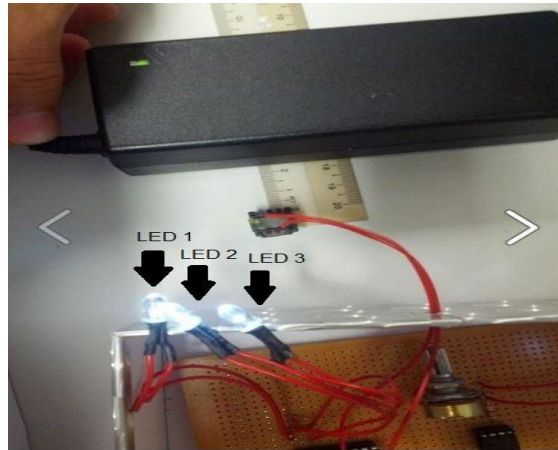


Figure 10: Graph of output voltage from Op-Amp at distance where the sensor was put 2.4cm from the EMF radiation source.

The graph shows an oscillating voltage output cycle from Op-Amp when the sensor was detecting EMF radiation at distance of 2.4 cm. The output voltage is at $3.2V_{P-P}$ at the frequency of 50Hz.

From the results above, we can conclude that when the sensor is put nearer to the source, the V_{P-P} will increase with the frequency remains unchanged. This is due to the higher level EMF radiation source (battery laptop charger).

B.2 Part 2

Voltage across led 1, led 2 and led 3 (all LEDs were glow) tested using digital millimeter.

Table 1: The observation number of LED and the voltage output.

LED	Voltage (V)
1	5.30
2	5.23
3	5.09

Based on the observation through the indicator of the LEDs, the nearer the sensor to the electromagnetic field, the more number of LEDs light. Thus, it shows that the value of the voltage become decreases as all the LEDs is light up.

IV. CONCLUSION & FURTHER RECOMMENDATION

This objective of project has been achieved successfully. Electromagnetic fields are present everywhere in our environment but are invisible to the human eye. Electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunderstorms. The earth's magnetic field causes a compass needle to orient in a North-South direction and is used by birds and fish for navigation. Besides natural sources the electromagnetic spectrum also includes fields generated by human-made sources: X-rays are employed to diagnose a broken limb after a sport accident. The electricity that comes out of every power socket has associated low frequency electromagnetic fields. And various kinds of higher frequency radio waves are used to transmit information – whether via TV antennas, radio stations or mobile phone base stations. The purpose of this project is to produce a detector that can detect the radiation in very low frequency (VLF) of electromagnetic radiation. The circuit used for this project is able to detect radiation in the range of 50Hz frequency where the result can be obtained through the flashing of LEDs. Based on the observation from the oscilloscope, the closer the distance between an EMF detector and electronic devices, the higher the voltage are produced. Moreover, the flashing of LEDs also increases as the device goes nearer to the EMF detector. Thus, it can be concluding that this EMF detector are able to detect the radiation and operates on a very low frequency. This electromagnetic field detector project can be upgraded by adding some of the modification of the circuit. For example, adding multiple of seven segments LED to the circuit in order to specify the value of the electromagnetic field among the electronic devices. Besides that, the sensing element also can be upgraded to detect higher frequency of electromagnetic filed.

V. ACKNOWLEDGEMENTS

The authors would like to thank Universiti Teknikal Malaysia Melaka (UTeM) and Ministry of Education Malaysia for the financial supports given through Research Grant.

REFERENCES

- [1] A. T. De Hoop, M. Stumpf, I.E. Lager; Pulsed Electromagnetic Field Radiation From a Wide Slot Antenna With a Dielectric Layer, *IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 59, NO. 8, AUGUST 2011*, pp 2789-2798
- [2] Dr Donna F. Smith, EMF Protection AND Energy Enhancement, *EMF REMEDIATION, Advance Clinical Nutrition*, 2006 pp1-30
- [3] K. Hajdarevic, C. Pattinson, A. Hadzic, J. Hadzigrabic, New Forensic Method for Measuring Dynamic Changes of EMF Level Limits Using Smart Dust, *Information, Communication and Automation Technologies (ICAT 2011)*, pp 1-5
- [4] T. Tricas, A. Grill, EFFECTS OF EMFS FROM UNDERSEA POWER CABLES ON ELASMOBRANCHS AND OTHER MARINE SPECIES, *US Department of the Interior, Pacific OCS Region*, September 2011, pp 1-426.
- [5] A. Zamanian, C. Hardiman, Electromagnetic Radiation and Human Health: A Review of Sources and Effects, *High Frequency Electronics, Summit Technical Media*, 2005, pp 16-26.
- [6] L. Yang, L. Guizhen, The research on biological effects of mobile phone radiation to human body, *IEEE Microwave Conference 2008, APMC 2008*, pp1-4.
- [7] MF Miskon, RA Russell, A novel electromagnetic signature sensor for mobile robots, *13th IASTED International Conference on Robotics and Applications*, August 2007, ACTA Press, pp 310-315.
- [8] Aslan, Edward E. , Netto Lane Plainview, (1993) Wide Power Range Electromagnetic Radiation Sensor, *European Patent Application 9380152*, 1993.
- [9] Yehoshua, System and Component for Detecting Electromagnetic Radiation and Displaying Images Produced Thereby, *European Patent Application 84304326.6*, 1997.